PB91-191262

Diaper Industry Workshop Report

Science Applications International Corp., McLean, VA

Prepared for:

Environmental Protection Agency, Cincinnati, OH

May 91

U.S. Department of Commerce
National Technical Information Service
NTIS

PB91-191262

EPA/600/2-91/018
May 1991

DIAPER INDUSTRY WORKSHOP REPORT

by:

Science Applications International Corporation
Cincinnati, Ohio 45203

Contract No. 68-C8-0061

Project Officer

Mary Ann Curran
Pollution Prevention Research Branch
Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

RISK REDUCTION ENGINEERING LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completi*		
1. REPORT NO. EPA/600/2-91/018	2.	3. PB91-191262
4. TITLE AND SUBTITLE Diaper Industry Workshop Report		5. REPORT DATE May 1991 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) SAIC		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS SAIC 635 West 7th Street, Suite 403 Cincinnati, OH 45203		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-C8-0061
12. SPONSORING AGENCY NAME AND ADDRESS Risk Reduction Engineering Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268		13. TYPE OF REPORT AND PERIOD COVERED Complete 14. SPONSORING AGENCY CODE EPA/600/14
15. SUPPLEMENTARY NOTES Mary Ann Curran, 513-569-7837; FTS 684-7837		

16. ABSTRACT

This report is the product of a one-day workshop on the diaper industry that was sponsored by the U.S. EPA. Four topics covered during the workshop were public health and safety, recycling, composting, and product life cycle analysis.

The primary objective of the workshop was to identify areas within the diaper industry that need further research in order to lessen the adverse impacts that diapers have on the environment. Summaries of each of the four topics as well as summaries of discussion comments and research needs identified during the workshop are included in the report.

A large number of research ideas were generated during the workshop. These ideas included determining the health risks associated with handling diapers, developing methods for improving the recyclability of plastics used in diapers, determining where diaper-related life cycle analysis should begin and end, and determining the economic viability of composting.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Public health, Safety, Circulation	Diaper Industry, Life cycle analysis, Diaper handling	
18. DISTRIBUTION STATEMENT Release to public	19. SECURITY CLASS (*This Report*) Unclassified 20. SECURITY CLASS (*This page*) Unclassified	21. NO. OF PAGES 36 22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

NOTICE

The information in this document has been funded by the U.S. Environmental Protection Agency under Contract No. 68-C8-0061 to Science Applications International Corporation. This document has been subjected to the Agency's peer review and administrative review, and has been approved for publication as a U.S. EPA document. Mention of trade names or commercial products does not constitute an endorsement or recommendation for use.

FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing and managing research, development and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

The Pollution Prevention Research Branch of the U.S. EPA's Risk Reduction Engineering Laboratory plans and conducts a major portion of the Agency's Pollution Prevention Programs. One significant segment of the Branch's effort is the Clean Products Research Program. One component of this program is to provide technology transfer for new ideas or methods to achieve pollution prevention.

The purpose of this project, which was undertaken as part of the Branch's technology transfer effort, was to conduct a 1-day workshop and prepare a report on the diaper industry. Prime emphasis of the workshop was to discuss the important issues associated with the diaper industry and the related research needs. The research needs identified in this report will be considered for future research efforts by EPA; however, priorities within the Agency will determine whether any projects are pursued.

E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ABSTRACT

This report is the product of a 1-day workshop on the diaper industry that was sponsored by the U.S. Environmental Protection Agency. Four topics were covered during the workshop: public health and safety, recycling, composting, and product life cycle analysis. The workshop was attended by more than 30 representatives from industry; local, state, and federal government agencies; academia; consulting firms; and waste handlers.

The primary objective of the workshop was to identify areas within the diaper industry that need further research that will lead to minimizing the negative effect that diapers have on the environment. Summaries of each of the four topics as well as summaries of discussion comments and research needs identified during the workshop are included in the report.

A large number of research ideas were generated during the workshop. These ideas included determining the health risks associated with handling diapers, developing methods for improving the recyclability of plastics used in diapers, determining the economic viability of composting, and determining where diaper-related life cycle analysis should begin and end. This report can be used by both the private and the public sector to pursue such research.

This workshop was held as part of EPA's continuing effort to transfer technical information to the public.

This report was submitted in fulfillment of contract no. 68-C8-0061 by Science Applications International Corporation (SAIC) under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from May 1990 to August 1990 and the work was completed as of January 1991.

CONTENTS

Notice ii
Foreword iii
Abstract iv
Figures vii
Acknowledgment viii

I. Introduction 1

A. Background 1
B. Purpose and Scope 1

II. Public Health and Safety 3

A. Washington State Infectious Waste Project Presentation 3
B. Discussion Comments 4
C. Summary of Research Needs 6

III. Recycling 8

A. Seattle Diaper Reclamation Project 8
B. San Diego Recycling Project 10
C. Discussion Comments 12
D. Summary of Research Needs 13

IV. Composting 14

A. St. Cloud, MN Diaper Compost Project 14
B. Sumpter County, FL Compost Facility 14
C. Discussion Comments 15
D. Summary of Research Needs 16

V. Product Life Cycle Analysis 17

A. General Overview of Life Cycle Analysis 17
B. Arthur D. Little Report 17
C. Discussion Comments 18
D. Summary of Research Needs 18

VI. Conclusion 19

VII. References 21

Appendices:
A. Diaper Industry Workshop Attendees 22
B. Diaper Industry Workshop Agenda 25

FIGURES

Number		Page
1	Rabanco Diaper Reclaim Process	9
2	Process Flow Chart for San Diego Recycling Project	11

ACKNOWLEDGEMENT

This report was prepared under the direction of Mary Ann Curran and Anne Robertson, Project Officers in the U.S. Environmental Protection Agency's (EPA) Risk Reduction Engineering Laboratory, Cincinnati, Ohio. This report is based upon the much appreciated participation of the attendees at the Diaper Industry Workshop. These attendees are as follows:

Joe Visalli
NY State Energy, Resource

Riley Kinman
University of Cincinnati

Beth Bower
Clean Cincinnati

Robert Case
Browning-Ferris Industries

Jack Shiffert
National Assoc. of Diaper Services

Mike Hall
Economy Linens

Anthony Montrone
A.D. Little, Inc.

Wayne Turnberg
Washington State Dept. of Ecology

Jere Sellers
Franklin Associates

Lynda Wynn
U.S. EPA, OSW

Herb Pahren
Consulting Engineer

Ralph Bernstein
Solid Waste Management Dept.

Ray Durkee
Kimberly Clark Corporation

Carl Lehrberger
EAC Systems

Terry Tognietti
Veragon Corporation

Tim Sergeant
Gerber Childrenswear

Nancy Eddy
Procter & Gamble

Steven C. Howard
Amerecycle

Nancy Healy
Recomp

Gerry Sheehan
Weyerhaeuser

Garry Howell
U.S. EPA, RREL

Lynnann Hitchens
U.S. EPA

Jeff Tryens
Center for Policy Alternatives

John Convery
U.S. EPA, RREL

Harry Freeman
U.S. EPA, RREL

Mary Ann Curran
U.S. EPA, RREL

Maggie Leshen
U.S. EPA, Region I

Marilyn Wade
U.S. EPA, Region I

Anne Robertson
U.S. EPA, RREL

Clyde Dial
SAIC

George Wahl
SAIC

James S. Bridges
U.S. EPA, RREL

This report was prepared for the Pollution Prevention Research Branch of the EPA's Risk Reduction Engineering Laboratory as part of the Clean Products Research Program by Clyde Dial and George Wahl of SAIC, under EPA Contract No. 68-C8-0061, Work Assignment No. 1-14.

I. INTRODUCTION

A. Background

The Pollution Prevention Research Branch of the U.S. EPA's Risk Reduction Engineering Laboratory (RREL) plans and conducts a major portion of the Agency's Pollution Prevention Research Programs. One significant segment of the Branch's effort is the Clean Products Research Program (CPRP). One component of this program is to provide technology transfer for new ideas or methods to achieve pollution prevention. A one-day workshop was held July 31, 1990 to discuss four important issues related to the diaper industry: public health and safety, recycling, composting, and product life cycle analysis. EPA personnel, diaper manufacturers, trade association representatives, municipal solid waste (MSW) disposers/reclaimers, and researchers participated in the workshop. A list of attendees is provided in Appendix A.

B. Purpose and Scope

The prime emphasis of the workshop was to discuss the important issues related to the diaper industry and related research needs. In order to encourage exchange of ideas and information and to avoid confrontation, the relative benefits of disposable versus reusable diapers were not addressed in this workshop.

The workshop was divided into four segments, one for each of the major issues, where topics of specific interest to achieving pollution prevention within the diaper industry were reviewed and discussed. For each of the workshop segments, presentations were followed by a general discussion among workshop participants.

The agenda for the workshop is presented in Appendix B. The workshop opened with statements from the Risk Reduction Engineering Laboratory who

welcomed attendees, described the pollution prevention programs and their importance, and outlined objectives of the workshop. Presentations and discussion of the four workshop topics took place during the remainder of the workshop.

This report is organized into separate sections for each of the four major topics covered in the workshop. The first portion of each section summarizes the presentations made at the beginning of that workshop segment. The summary is followed by a listing of significant points or issues identified during the discussion period, and a listing of pollution prevention research needs related to that topic. These research needs are limited to the knowledge of the participants at the workshop and are not meant to be comprehensive. In addition, some of the issues discussed in this report may have already been researched, but the workshop participants were unaware of the research.

II. PUBLIC HEALTH AND SAFETY

A. Washington State Infectious Waste Project Presentation (Wayne L. Turnberg)

In response to concerns about medical wastes washing ashore, the State of Washington's legislature ordered a study to assess the risk of human infectious disease acquired during the course of solid waste disposal.[1] The report found that human wastes, which may contain human pathogens, were entering the solid waste stream by many routes, including disposable diapers. The report stated that human feces and urine found on disposable diapers often contain human pathogens, and that these pathogens can survive and be transmitted to humans coming into contact with them. Nevertheless, disposable diapers do not meet the EPA criteria of an infectious waste unless the diaper wearer is being isolated to protect others from specific highly communicable diseases.[2]

Actual spread of infection requires all of the following: a source or reservoir of pathogenic microorganisms, a susceptible host, a pathway or mode of transmission to the host, an infective dose of pathogen capable of overwhelming the host's defenses, and a means for the pathogen to enter the host. Proper hygiene and safety practices, along with education, will significantly reduce waste workers contact with infectious agents.

The presence of pathogens in the solid waste stream has caused concerns about the migration of microorganisms from landfills. Viruses may be inactivated because of high temperature (140° F) typically associated with the initial aerobic environment in municipal solid waste landfills. The presence of microorganism stressors such as pesticides, drugs and heavy metals often found in landfills may also contribute to inactivation of viruses. One study which examined landfill leachate for the presence of viruses identified

viruses at only 1 of 22 sites, and that site was described as not properly maintained or operated. Although viruses and bacteria may survive in a landfill, their migration from a properly operated landfill is unlikely. Their movement in the soil is dependent upon many factors, such as soil texture/composition, soil moisture, salt concentrations, pH, climate, nutrient availability, and antagonisms. Another deterrent to migration may be the adsorption properties of the fill material.

It can be concluded from the Washington State Report that human pathogens are routinely introduced into the waste stream from residential as well as medical waste stream sources and that these pathogens travel with the waste to municipal solid waste landfills. Once in a properly operated landfill, pathogens are not likely to migrate, and may become inactive. No evidence of human infectious disease from infectious agents present in municipal solid waste landfills or the waste stream was identified based on the literature search conducted for the report.

B. Discussion Comments

The discussions on public health and safety focused on the spread and survivability of pathogens in the wastestream. These discussions are summarized as follows:

- Participants noted that pathogens in landfills represent a risk and questioned how much of that risk is associated with pathogens from disposable diapers. Some participants suggested that the fraction of pathogens in landfills from disposable diapers needs to be determined so that their relative risk can be assessed. Other participants questioned the feasibility of doing such a study. Participants also noted that animal wastes and sewage sludge are examples of other significant sources of pathogens which should be examined. The bacteriological contribution of various categories of solid waste has been quantified by EPA;[3] however, the report is not comprehensive.

- The potential for disease from inhalation of airborne pathogens from reusable diaper pails and waste containers for disposable diapers needs to be investigated. The head space of pails or bags may contain aerosol mist which could be released. The ability of diaper bags to resist puncture is important to the health of those handling the bags. Another concern is the use of biodegradable plastics. These bags are weaker and, therefore, cause greater potential risk to waste handlers.

- While reusable diapers do not enter the solid waste stream, the survivability of pathogens is a potential concern for the handler and the user. Contact at central processing facilities is minimized by the use of personal protective equipment, including protective clothing, gloves and face masks. Studies are now being conducted using magnetic indicators on the diapers to conduct in-bag counting and thus reduce handling of soiled diapers. No instances of illness from soiled reusable diapers have been reported. This lack of established illness may be due to the elevated temperatures and chlorine bleach used by diaper services. In Europe, enzymes are being used in the wash process to eliminate diaper bacteria. It was speculated that control of diaper bacteria is more difficult during home laundering because of the limitations of the equipment; however, there have been no reports of disease from laundered diapers.

- Concern existed about landfills in close proximity to aquifers. A recent finding of fecal coliform in test wells at an improperly operated landfill was noted. It was suggested that the EPA establish minimum criteria for landfills allowed to accept disposable diaper waste.

- The occurrence and survivability of pathogens in solid waste and their potential to cause disease in recycling, composting, and incineration operations should be considered. Hand-sorting in these operations requires proper ventilation and personal protective equipment such as protective clothing, gloves and face masks. Recycling and composting require increased handling during their operation, while mass burn incineration needs little or no additional handling.

Other discussion about considerations for future reports on human infectious disease associated with municipal solid waste included:

- Literature searches should include studies conducted in foreign countries. One participant noted that 40% of sanitation workers in India have lung disease.

- Future studies on waste worker health and safety need to include the threat of infectious disease from collecting, transporting and

processing solid waste. The American Federation of State and County Workers is a potential source for acquiring data on worker health. One participant noted that only 25% of sanitation workers are trained in handling infectious waste.

C. Summary of Research Needs

Human exposure considerations as they relate to the diaper industry must be further examined. These studies will result in better understanding of the human exposure aspects of handling and processing soiled diapers, thereby addressing concern for these issues and providing ways to control such exposure. Examples of creditable information that should be obtained and distributed are as follows:

- A study of occupational infection risk to waste workers and the source of that risk using serologic markers for hepatitis B and other appropriate pathogens is needed. This study should identify risks due to activities associated with collection, handling and processing of waste materials for pollution prevention purposes. The study should include the "total" handling system of various solid waste disposal methods from both a health and safety standpoint.

- A study of the captured aerosols found in the void spaces of closed receptacles (ie. plastic trash bags) containing soiled diapers and their impact on humans during handling and collection of these containers by reusable diaper services is needed. Human exposure to these aerosols during the laundering of reusable diapers should be evaluated. Exposure assessments during collection of disposable diapers and their handling during recycling or composting are needed.

- An epidemiological study to determine any health risk associated with recycling or composting practices of solid waste should be conducted.

Additional public health and safety research not related directly to human exposure should:

- Examine the survivability of pathogens in the reusable diaper wash process.

- Evaluate different biocides used for sanitizing reusable diapers.

- Define quantitatively, the sources of microorganisms which enter the waste stream, including human and animal wastes.
- Determine the need for biological testing of landfills to monitor human pathogens.
- Study the macro effects of combining sewage sludge with the municipal solid wastestream.

III. RECYCLING

A. Seattle Diaper Reclamation Project (Nancy Eddy)

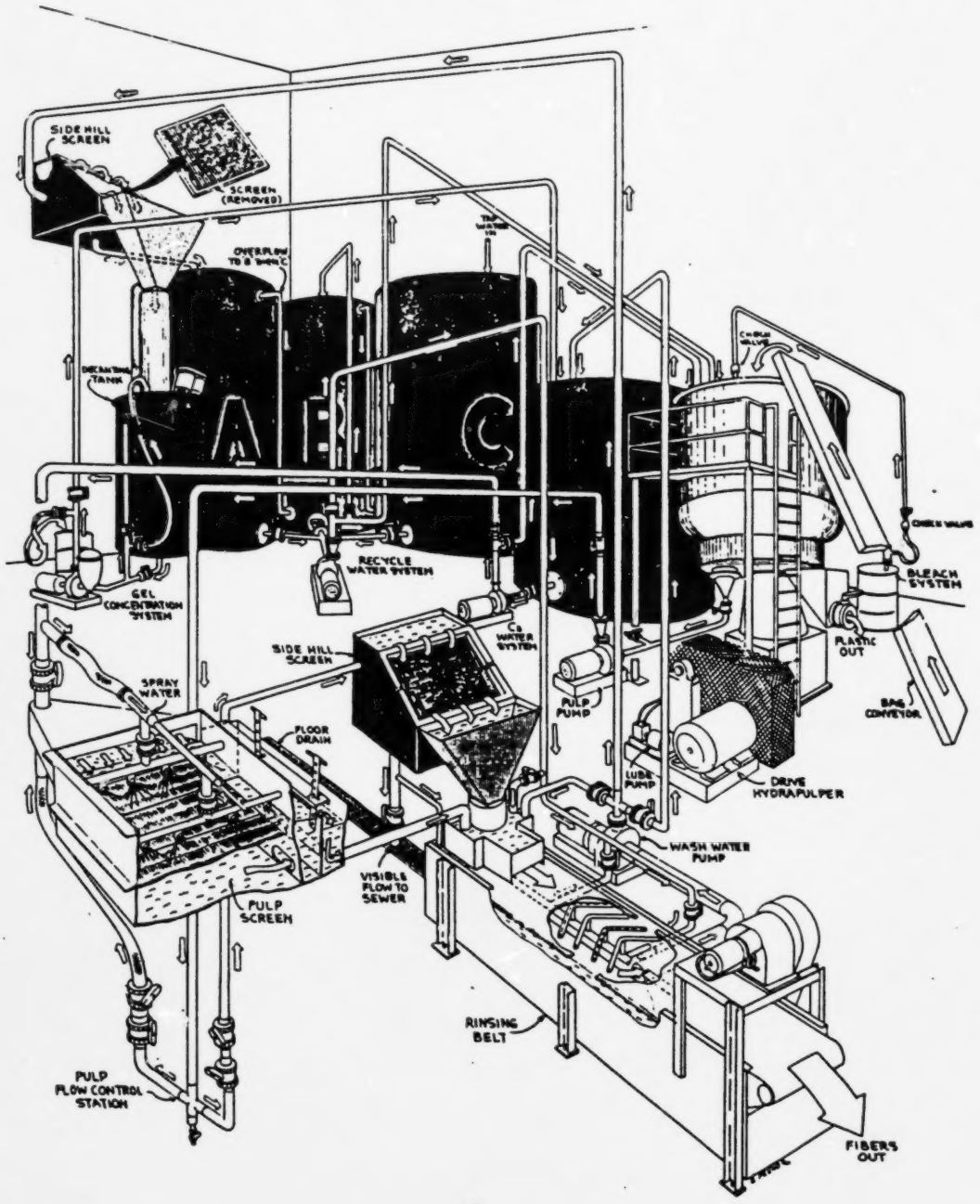
A 3-month pilot project to separate and recycle the components of disposable diapers was started in June of 1990 in Seattle, Washington. This effort was initiated to determine the technical and economic feasibility of reclaiming disposable diapers. The project is a cooperative effort between Procter & Gamble, a disposable diaper manufacturer; the Seattle Solid Waste Utility; a local diaper service for pickup and delivery; and Rabanco, a solid waste recycling firm.

The batch process begins with bags of soiled disposable diapers conveyed to a hydrapulper where they are sanitized with sodium hypochlorite. The plastic and pulp components are then separated. After the waste is removed and the gel separated, the water is sent to a series of tanks and recycled. Fibers are screened, rinsed and eventually bailed. Co-mingled plastics are recovered from the hydrapulper. A diagram of the Rabanco Diaper Reclaim process is shown in Figure 1.

The pulp's value is estimated at $400-$450/ton. The sale of the co-mingled plastic at $0.02/lb would cover the cost of transporting it to the market. Although reclaimed absorbent gelling material is not currently very marketable, it is hoped that the gelling material can be used as an agricultural additive to improve moisture retention.

The projected activities for the Seattle project have been identified. They include determining the potential market for reclaimed pulp, plastic and gel materials. The Seattle Solid Waste Utility will complete an economic evaluation which will be verified by an independent consulting firm. If the process is deemed economically feasible, the project will be turned over to Rabanco for continuous processing of disposable diapers.

FIGURE 1. Rabanco Diaper Reclaim Process



Reproduced from best available copy.

B. San Diego Recycling Project (Gerry Sheehan)

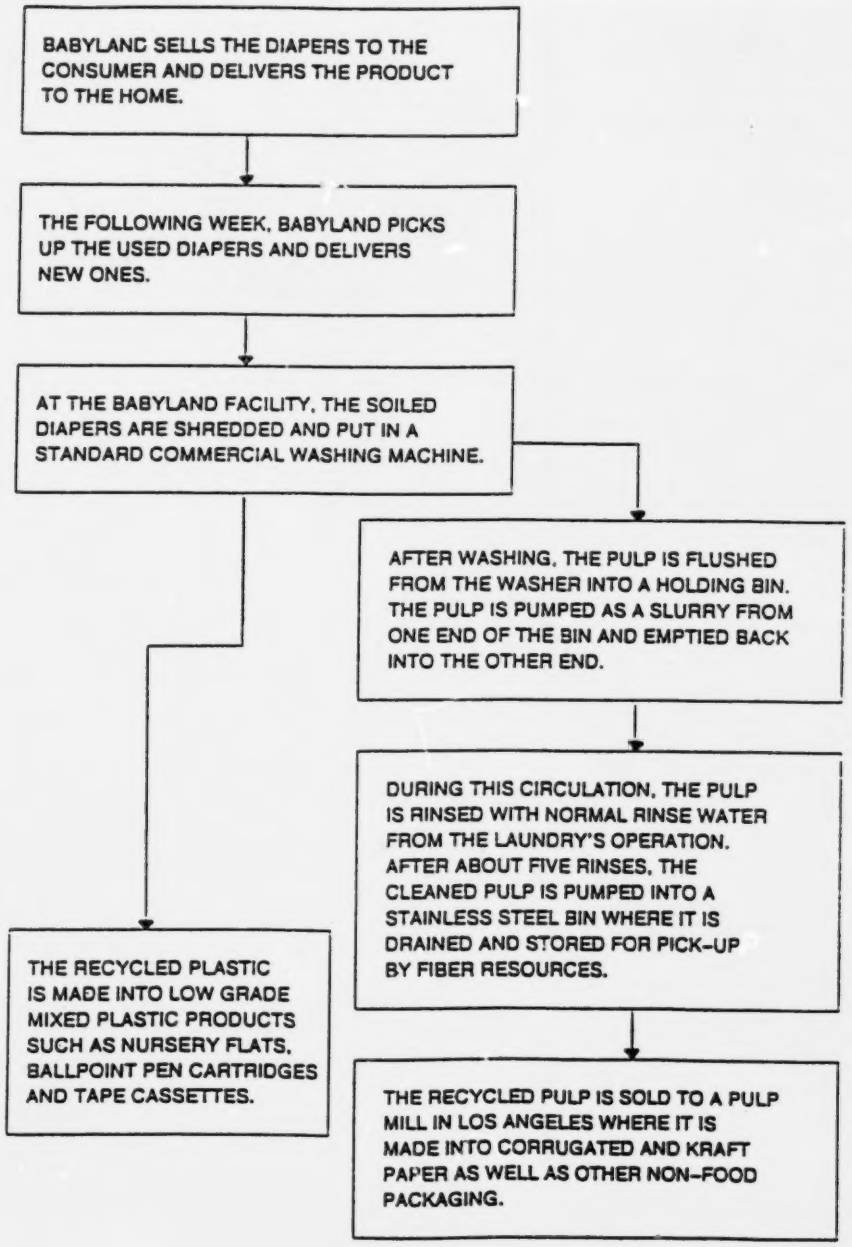
Weyerhaeuser tried to design a recycling process that was economically feasible, not sensitive to market fluctuations, not capital intensive, and did not require a major change of current consumer habits. The five companies involved in the project were Weyerhaeuser, a disposable diaper manufacturer; Babyland, a diaper service; Cirrus Corporation, a recycling equipment supplier; Fiber Resources, a pulp processor; and Western Gold Thermoplastics, a plastic processor.

The process is shown in the flow chart shown in Figure 2. The sanitizing and separation processes are carried out in a standard commercial washer. The heat of the wash water is sufficient to separate the plastic from the pulp. The only capital investments were the pumps, screens and washer.

The project did reveal some drawbacks in reclaiming disposable diapers. The recovered pulp was contaminated with absorbent gel material. The process resulted in high water usage. The project used only diapers supplied through a diaper service and did not involve diapers sold through the retail market. Delivery and pickup of diapers are a significant cost. The small scale of the project was also a problem since large quantities of pulp could not be readily produced. This caused the pulp to mildew while it awaited shipment for further processing. An over-supply of virgin pulp also made pulp processors reluctant to purchase reclaimed pulp.

Weyerhaeuser has identified important issues for future efforts. They include proving that their reclaimed pulp's purity is not impaired because of gel contamination. The pulp will be tested for composting. They are exploring low-cost methods for extracting gel. Ways of including disposable diapers from the retail trade in the collection program need to be investigated.

FIGURE 2. Process Flow Chart for San Diego Recycling Project


BABYLAND SELLS THE DIAPERS TO THE CONSUMER AND DELIVERS THE PRODUCT TO THE HOME.
THE FOLLOWING WEEK, BABYLAND PICKS UP THE USED DIAPERS AND DELIVERS NEW ONES.
AT THE BABYLAND FACILITY, THE SOILED DIAPERS ARE SHREDDED AND PUT IN A STANDARD COMMERCIAL WASHING MACHINE.
AFTER WASHING, THE PULP IS FLUSHED FROM THE WASHER INTO A HOLDING BIN. THE PULP IS PUMPED AS A SLURRY FROM ONE END OF THE BIN AND EMPTIED BACK INTO THE OTHER END.
DURING THIS CIRCULATION, THE PULP IS RINSED WITH NORMAL RINSE WATER FROM THE LAUNDRY'S OPERATION. AFTER ABOUT FIVE RINSES, THE CLEANED PULP IS PUMPED INTO A STAINLESS STEEL BIN WHERE IT IS DRAINED AND STORED FOR PICK-UP BY FIBER RESOURCES.
THE RECYCLED PLASTIC IS MADE INTO LOW GRADE MIXED PLASTIC PRODUCTS SUCH AS NURSERY FLATS, BALLPOINT PEN CARTRIDGES AND TAPE CASSETTES.
THE RECYCLED PULP IS SOLD TO A PULP MILL IN LOS ANGELES WHERE IT IS MADE INTO CORRUGATED AND KRAFT PAPER AS WELL AS OTHER NON-FOOD PACKAGING.

C. Discussion Comments

Discussions pointed out a number of issues related to difficulties associated with using recycled materials. These issues are:

- The presence of residual gelling material in pulp can cause flaws in the paper produced.
- Co-mingling of polyethylene and polypropylene reduces the value and marketability for plastic reclaimed from disposable diapers.
- Pulp and plastic cannot be recycled repeatedly. Each recycling of pulp and paper has a deteriorating effect on the quality of the material.
- Because of current negative public perception, reclaimed pulp is not being used again for many products including disposable diapers.
- The presence of biodegradable plastic can hamper the market value of reclaimed, co-mingled plastic. Agents added to biodegradable plastics, e.g. cornstarch, also cause the plastic to be weaker.
- Distance from a pulp buyer would significantly affect economic viability.
- Collection may not be economical especially in more rural areas.

Other issues related to recycling which were discussed included:

- Care has to be taken to insure that recycled materials do not contain pathogens.
- The greatest cost for the Seattle project was for separate collection of diapers.
- Manufacturers may risk loss of market share if their product requires a change in consumer habits.
- Recycling projects have to prove economic feasibility before private industry will make any kind of national or large-scale effort to recycle diapers or any other product.
- Government efforts could enhance markets for recycled materials if current procurement practices/regulations are changed to increase the use of recycled materials. This would improve the economic feasibility

of recycling disposable diapers.

- Disposable diaper manufacturers are looking at other possible changes to make their product more amenable to alternative disposal options.
- A new generation of bioreacting landfills may reduce the need for recycling.
- Not all of the material reclaimed from recycling programs and sent to markets find their way into new and useful products. A portion of the recycled material is rejected and discarded.

D. Summary of Research Needs

Research related to improving the quality of recycled diaper material should:

- Determine the impact of contamination by gelling material on pulp quality.
- Explore low-cost methods for extracting gelling material.
- Find methods to efficiently separate different types of plastics.
- Develop catalysts which enhance the properties of co-mingled plastics.
- Study the feasibility of reducing the diversity of plastic for diaper liners, bags, adhesive strips, and elastics.
- Evaluate the impact of different collection and separation methods on the cost of recycling and consumer acceptance.
- Conduct material balances to determine how much reclaimed pulp and paper is actually returned to the market and not discarded as process waste.
- Determine the energy requirement for reclamation.
- Collaborative efforts among the U.S. EPA, the Department of Commerce, the Food and Drug Administration, and the General Services Administration should examine which government actions can selectively "promote" use of reclaimed materials.

IV. COMPOSTING

A. St. Cloud, Minnesota Diaper Compost Project (Nancy Healy)

The project at St. Cloud, Minnesota was initiated to demonstrate the viability of composting disposable diapers. The project, which examined the quality of the compost produced from disposable diapers, was conducted from October 9, 1989 to December 21, 1989 at an existing St. Cloud composting facility. The participants were Procter & Gamble Company, a manufacturer of disposable diapers; Recomp, Inc., a vendor of MSW handling equipment; and Supercycle, a recycling company.

In order to magnify the effects of disposable diapers, the percentage of disposable diapers entering the composter was increased from approximately 2% to 7.6% of the municipal solid waste feed. Diapers were picked up curbside in St. Paul, Minnesota and driven 90 miles to the St. Cloud facility. The waste was sorted and digested for three days in a three-chamber, aerobic, rotary drum composter. The process did not involve any shredding or hammer milling. Material over 1½" in diameter was screened out before being sent outside for curing. Once the compost was cured, analytical data were obtained and agricultural studies were begun.

At the time of this workshop, the study was being finalized. A final report is expected in the fall of 1990. The compost produced did not appear to differ from normal compost produced at the St. Cloud facility. Although the plastic backsheets were not compostable, they were easily removed from the process by the 1½" screens.

B. Sumpter County, Florida Compost Facility (Steve Howard)

A composting facility was constructed in Sumpter County, Florida to extend

the life of the county's current landfill. The facility was designed and is operated by Amerecycle. Since Sumpter County is mostly rural, curbside recycling was not considered. All municipal solid waste is delivered to one processing facility. The municipal solid waste has to pass through various pre-processing steps before being composted. These include segregation of household hazardous waste, shredding, magnetic separation, metal detection, hand-sorting, moisture addition, and additional shredding. The waste exits with a particle size ranging from one to three inches and is moved to open-air windrows. Aeration and inoculation with microorganisms are used to promote composting. To date, the facility has not been involved in a comprehensive diaper study. Nevertheless, no operational problems have been encountered from disposable diapers routinely processed at the facility.

C. Discussion Comments

Discussions specific to composting included:

- The practice of using hand-sorting stations requires prudent safety and health considerations such as using protective clothing, gloves and face masks to minimize contact with infectious agents present in municipal solid waste.
- Composting of municipal solid waste may be affected if the proposed regulation to allow low-level radioactive waste into the MSW is enacted.
- The Sumpter County facility is willing and available to participate in research projects involving composting.
- Hazardous/illegal wastes especially from larger metropolitan areas could be a problem in composting.

Other discussions which were more general in nature included:

- Attention should be given to the order of priorities for handling/managing wastes. Source reduction first; then recycling, reuse, and composting; then waste to energy; and finally, landfilling as a last resort.

- When studying waste options, local geographic and demographic considerations should be taken into account (i.e., rural-vs-urban waste).

D. Summary of Research Needs

Further research in composting should do the following:

- Conduct a systems study comparing composting to landfilling.
- Compare sewage sludge composting vs. MSW composting.
- Perform pilot studies on the separation of diaper materials.
- Examine how trace impurities (like gel material) affect the quality of compost material.
- Determine the economic viability of composting.

Other research not directly related to composting should:

- Compare aerobic-vs-anaerobic degradation in a controlled landfill with an outlet provided to collect methane.
- Conduct feasibility studies on the development and use of a flushable diaper.

V. PRODUCT LIFE CYCLE ANALYSIS

A. General Overview of Life Cycle Analysis (Jere Sellers)

A life cycle is sometimes referred to as a resource and environmental profile analysis (REPA). It provides one piece of a decision-making process. The first true life cycle study was done for Coca Cola in 1969. Coca Cola wanted to compare and evaluate different packaging options in order to predict a change in its emphasis from bottles to cans or visa versa. Since then, a fast growing trend to do life cycle studies has developed. Franklin Associates is currently doing a life cycle analysis on various diaper products for the American Paper Institute. This report is being finalized and may be available in August 1990. Data Resources, Inc. is performing a life cycle analysis for the reusable diaper industry. This report will be available in Mid-October 1990.

When doing a life cycle study to examine environmental aspects for any product there are multi-media factors such as energy use, natural resource use, air quality, water quality, and land quality that must be considered. Comparison of products within a life cycle analysis must be fair and unbiased.

B. Arthur D. Little Report (Anthony Montrone)

Arthur D. Little's life cycle analysis on diapers was used to study disposable versus reusable diapers. It compared health, environmental and economical aspects of both diaper types. Data representing real world conditions were used whenever possible. For instance, A.D. Little surveyed some of its employees (about 1,600 people) on their diapering practices. A.D. Little made several assumptions, such as their decision to ignore the impact of harvesting trees or growing cotton. Sensitivity studies showed that the impact of such factors as the energy used by wastewater treatment plants could be ignored without affecting the final results. The overall environmental

conclusion was that both diapering systems have negative impacts. Disposable diaper manufacture and use generates more municipal solid waste as compared to reusable diapers. Reusable diapers result in more energy and water usage and higher levels of total air and water pollution.[4]

C. Discussion Comments

Discussion centered on questions of how to conduct life cycle analysis. Specific points or assumptions that were used in the analysis, such as methods for determining weighted averages or ratios used, were also discussed. Some assumptions used in the A. D. Little report were questioned such as the decision to assume 1.9 cloth diapers per change and the ratio of 90% of cloth diapers are laundered at home while 10% are provided by diaper services.

Another issue raised during this discussion addressed the impacts that would occur on the solid waste treatment path and wastewater treatment path in the event of a substantial shift from public use of disposable diapers to cloth diapers requiring laundering.

D. Summary of Research Needs

Research needs related to life cycle analysis centered on the need to provide guidance on approaches to conducting these analyses and their use. Further life cycle studies should do the following:

- Identify which variables cause significant impact on final results for all diaper-related life cycle analyses.
- Determine where diaper-related life cycle analysis should begin and end.
- Use life cycle analysis to find target areas that should be changed to reduce the environmental impacts of both single-use and reusable diapers.

VI. CONCLUSION

The workshop focused on four important issues related to the diaper industry: public health and safety, recycling, composting and product life cycle analysis techniques. It appeared that a majority of the participants felt that the health and safety issues related to diapers currently receive more public scrutiny than is warranted. It was concluded that there is probably no significant public health and safety problems related specifically to diaper handling, recycling or disposal in properly operated and constructed landfills. However, because diaper disposal is a highly visible issue to the public, more definitive health and safety studies should be conducted on the handling and processing of diapers. This would enable public health officials to clearly define any health and safety issues related to diaper handling and to dispel unwarranted fears about health problems associated with diapers.

The issues related to recycling and composting of diaper materials focused on the economics required to make these technologies viable. The consensus of the participants was that the major issues related to recycling, beyond making it economically feasible, were the quality of the product and the acceptance of recycled materials in the marketplace.

In the product life cycle analysis discussion, it was concluded that these techniques are an excellent way to identify aspects of a product's life cycle that can be targeted for further study. Such studies would focus on ways to increase the length of product life, the reuse of product materials, or ways of producing the product that result in less waste.

Many research needs were identified during the course of this workshop. Further investigation into these research issues by both the private sector

and the public sector will lead to opportunities to lessen the adverse environmental impacts of diapers and to improve the health and safety of those who come into contact with diapers. Initiation of research projects in this area by EPA is contingent on the priorities of the Agency.

VII. REFERENCES

1. Turnberg, W. L. Human Infection Risks Associated with Infectious Disease Agents in the Wastestream: A Literature Review, Chapters I and II. In: Washington State Infectious Waste Project - Report to the Legislature, Attachment I, Washington State Department of Ecology, Olympia, Washington, December 1989.

2. Standards for the Tracking and Management of Medical Waste; Interim Final Rule and Request for Comments. Federal Register, March 24, 1989; 54(56):12326-12395.

3. Pahren H. Microorganisms in Municipal Solid Waste and Public Health Implications, CRC Critical Review in Environmental Control, Vol. 17, Issue 3, pp. 187-228, 1987.

4. Arthur D. Little, Inc. Disposable Versus Reusable Diapers: Health, Environmental and Economic Comparisons, Report to Procter and Gamble, Reference 64190, March 16, 1990, Sec. I, pp. 1-11.

APPENDIX A

DIAPER INDUSTRY WORKSHOP ATTENDEES

July 31, 1990

Joe Visalli
NY State Energy, Resource, and
Development Authority
2 Rockefeller Plaza
Albany, NY 12223
(518) 465-6251

Ralph Bernstein
Solid Waste Management Dept.
Montgomery County Building
Dayton, OH 45422
(513) 225-6145

Riley Kinman
University of Cincinnati
Dept. of Civil & Env. Engineering
Location 71
Cincinnati, OH 45221
(513) 556-3694

Ray Durkee
Kimberly Clark Corp.
2100 Winchester Rd.
Neenah, WI 54956
(414) 721-5390

Beth Bower
Clean Cincinnati
3320 Mill Creek Rd.
Cincinnati, OH 45223
(513) 352-6319

Carl Lehrberger
EAC Systems
79 N. Pearl St.
Albany, NY 12207
(518) 434-1227

Robert Case
BFI
11563 Mosteller Rd.
Cincinnati, OH 45241
(513) 771-4200

Terry Tognietti
Veragon Corp.
1415 West Loop North
Houston, TX 77055
(713) 682-6848

Jack Shiffert
National Assoc. of Diaper Services
2017 Walnut St.
Philadelphia, PA 19103
(215) 569-3650

Tim Sergeant
Product Development Manager
Gerber Childrenswear
P.O. Box 3010
Greenville, SC 29602
(803) 240-2840

Mike Hall
Economy Linens
80 Mead Street
Dayton, OH 45402
(513) 222-4625

Nancy Eddy
Procter & Gamble
Winton Hill Tech. Center
Paper Building
6100 Center Hill Road
Cincinnati, OH 45224
(513) 634-5417

Anthony Montrone
A. D. Little, Inc.
Environmental, Health, and Safety
Practice
Acorn Park
Cambridge, MA 02140-2390
(617) 864-5770

Steven C. Howard
Amerecycle
P.O. Box 338
Sumpterville, FL 33585
(904) 568-0666

Wayne Turnberg
Washington State Dept. of Ecology
4350 150th Ave. NE
Redmond, WA 98052
(206) 867-7030

Nancy Healey
Recomp
1720 South Bellaire St.
Suite 701
Denver, CO 80222
(303) 753-0945

Jere Sellers
Franklin Associates
4121 W. 83rd St., Suite 108
Prairie Village, KS 66208
(913) 649-2225

Gerry Sheehan
Weyerhaeuser
Kent Technical Center 20232
72nd Ave. South
Kent, WA 98032
(206) 924-4514

Lynda Wynn
U.S. EPA
OSW (OS-301)
401 M. Street, S.W.
Washington, D.C. 20460
(202) 475-7700

Garry Howell
U.S. EPA
RREL (MS-466)
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
(513) 569-7756

Herb Pahren
Consulting Engineer
5995 Center Hill
Cincinnati, OH 45224
(513) 569-7871

Jeff Tryens
Center for Policy Alternatives
2000 Florida Ave., N.W.
Suite 400
Washington, D.C. 20009
(202) 387-6030

Harry Freeman
U.S. EPA
RREL (MS-466)
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
(513) 569-7529

Maggie Leshen
U.S. EPA
Region I (MC-HECAN6)
JFK Federal Building
Room 2203
Boston, MA 02203
(617) 573-9660

Anne Robertson
U.S. EPA
RREL (MS-466)
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
(513) 569-7658

George Wahl
SAIC
635 W. 7th St.
Suite 403
Cincinnati, OH 45203
(513) 723-2607

Lynnann Hitchens
U.S. EPA
5995 Center Hill
Cincinnati, OH 45224
(513) 569-7672

John Convery
U.S. EPA
RREL (MS-235)
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
(513) 569-7896

Mary Ann Curran
U.S. EPA
RREL (MS-466)
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
(513) 569-7837

Marilyn Wade
U.S. EPA
Region I (MC-HECAN6)
JFK Federal Building
Room 2203
Boston, MA 02203
(617) 573-5723

Clyde Dial
SAIC
635 W. 7th St.
Suite 403
Cincinnati, OH 45203
(513) 723-2600

James S. Bridges
U.S. EPA
RREL (MS-466)
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
(513) 569-7683

APPENDIX B

DIAPER INDUSTRY WORKSHOP
AGENDA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANDREW BREIDENBACH ENVIRONMENTAL RESEARCH CENTER
ROOM 120/126
CINCINNATI, OH

JULY 31, 1990

8:30 **WELCOME AND OPENING REMARKS**

John Convery
Deputy Director, Risk Reduction Engineering Laboratory

Harry M. Freeman
Chief, Pollution Prevention Research Branch, WMDDRD

8:45 **INTRODUCTION**

Purpose and Scope
Mary Ann Curran, EPA, RREL

9:15 **PUBLIC HEALTH AND SAFETY**

Landfill Impact (15 minutes)
Wayne Turnberg, Washington State Dept. of Ecology

General Discussion (45 minutes)

10:15 **BREAK**

10:30 **RECYCLING**

Seattle Project (15 minutes)
Nancy Eddy, Procter and Gamble

San Diego Project (15 minutes)
Gerry Sheehan, Wyerhaeuser

General Discussion (60 minutes)

12:00 **LUNCH**

1:15 **COMPOSTING**

St. Cloud Project (15 minutes)
Nancy Healey, Recomp

Sumpter County, Florida Project (15 minutes)
Steven Howard, Amerecycle

General Discussion (60 minutes)

2:45 **BREAK**

3:00 **PRODUCT LIFE CYCLE ANALYSIS**

Jere Sellers, Franklin Associates (15 minutes)

Anthony Montrone, A.D. Little (15 minutes)

General Discussion (60 minutes)

4:30 **WRAP-UP/CONCLUSIONS**

4:45 **END**